Nov. 24, 1964 A. P. WARREN ETAL 3,158,336

ASSEMBLY FOR RECOVERING A CAPSULE

Filed Sept. 5, 1962 3 Sheets-Sheet 1

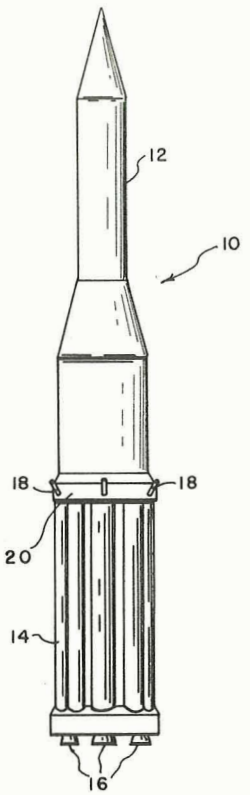

FIG. 1

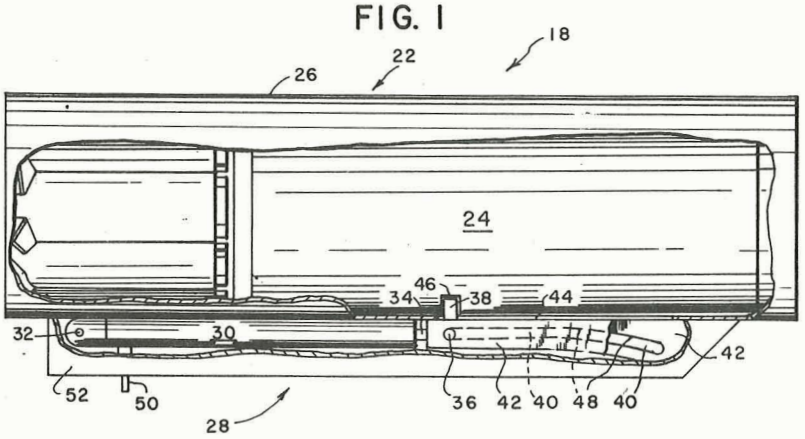

FIG. 2

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Filed Sept. 5, 1962 3 Sheets-Sheet 2

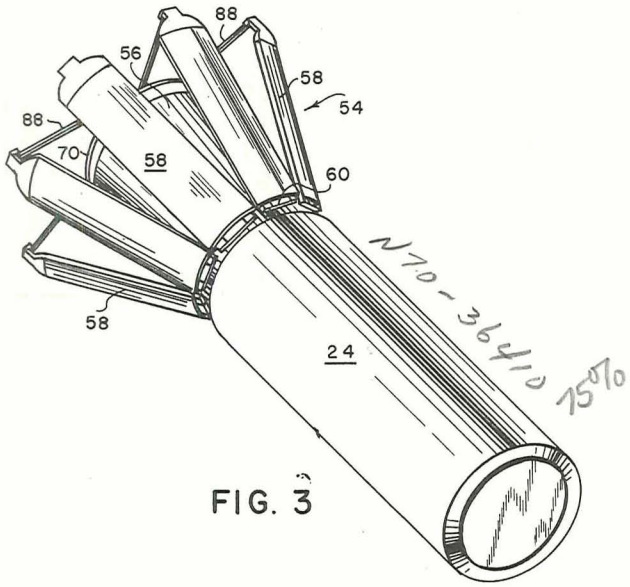

FIG. 3

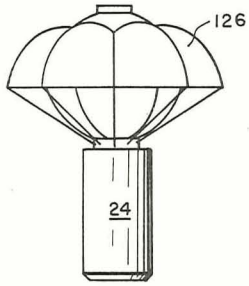

FIG. 4

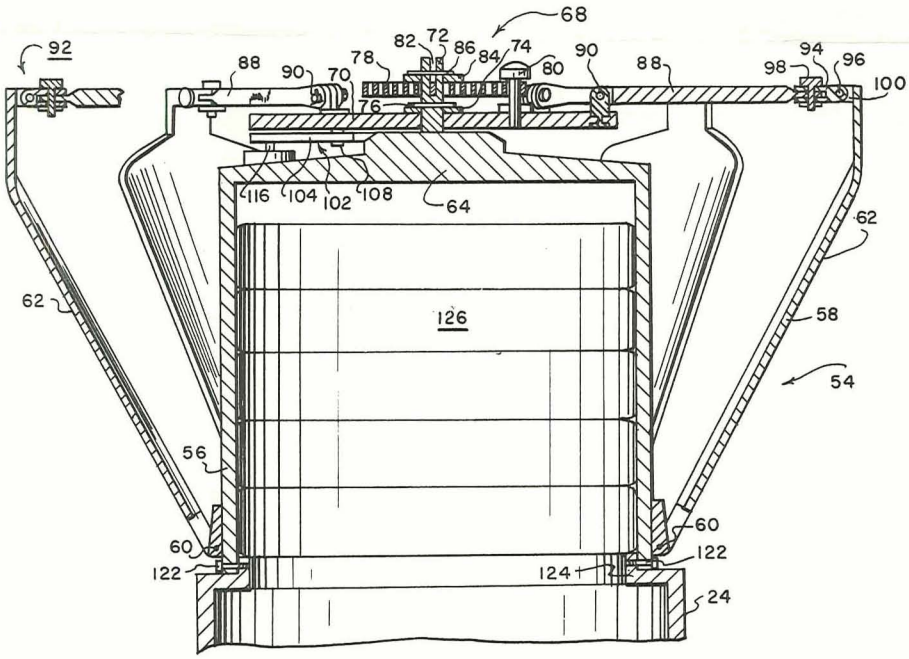

FIG. 5

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Nov. 24, 1964 A. P. WARREN ETAL 3,158,336

ASSEMBLY FOR RECOVERING A CAPSULE

Filed Sept. 5, 1962 3 Sheets-Sheet 3

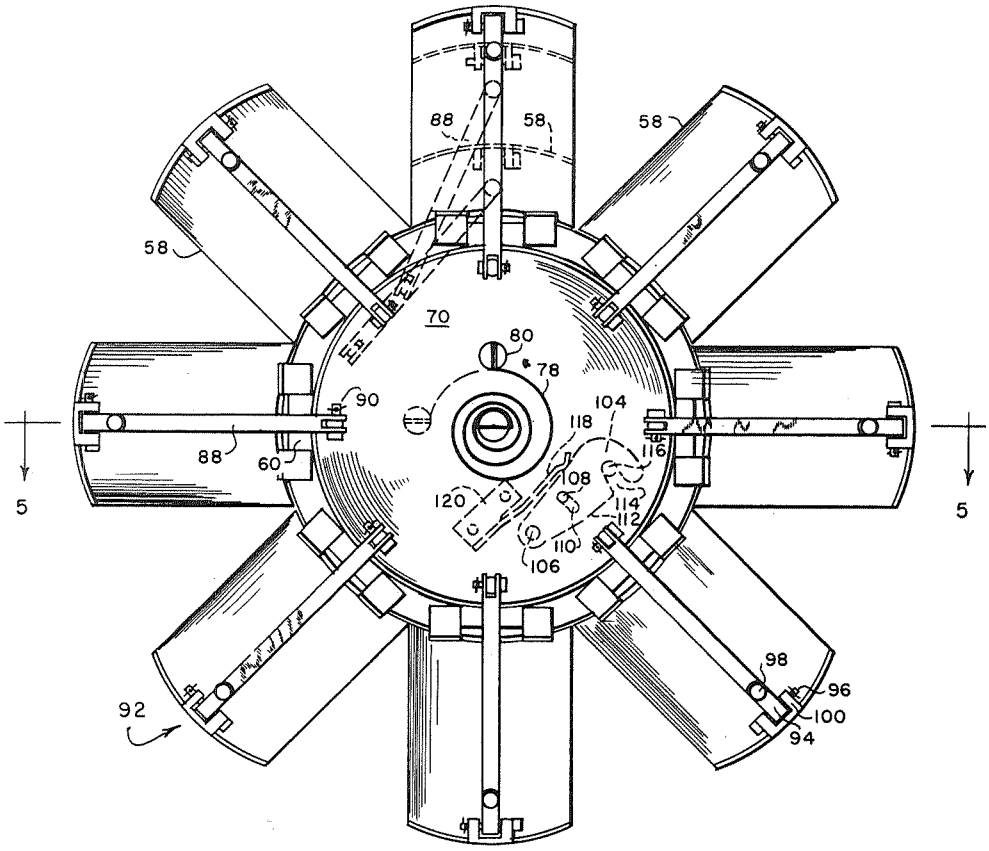

FIG. 6

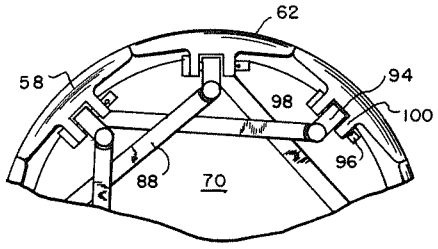

FIG. 7

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ASSEMBLY FOR RECOVERING A CAPSULE

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6 Claims. (Cl. 244—1)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The present invention relates generally to means for recovering flight capsules used in space research and more particularly to an improved assembly for opening the stabilizing and decelerating flaps of such a capsule.

In the development of aerodynamic bodies or capsules which collapse for packaging purposes, it has become a common practice to provide mechanisms for stabilizing the capsule against tumble and spin and for increasing the drag force thereon during its free fall through the upper atmosphere toward the earth. These mechanisms, in general, consist of a plurality of flaps which usually form a part of the main body portion of the capsule and are pivotally mounted directly thereto so as to permit them to be opened and collapsed to operative and inoperative positions, respectively. Numerous mechanical devices have been devised for opening the flaps but, basically, they are of two different types. One type is a so called umbrella opening device which operates similar to the conventional opener for umbrellas. This opening device consists of a member slidable on a trackway mounted inside of the capsule and pivotable rods or cam elements interposed between the slidable member and the pivotally mounted flaps. The other type is a spring opening device which utilizes an individual leaf or coil spring positioned between the capsule and each flap. The individual spring is normally used in conjunction with a hinge element which pivotally mounts each flap to the capsule. Various types of conventional locking mechanisms for holding the flaps in their opened and collapsed positions have also been used on the stabilization and deceleration mechanisms employing these prior types of mechanical devices for opening the flaps.

Although, in general, the above types of stabilization and deceleration mechanisms have performed satisfactorily to some extent, they have not been found to be entirely suitable where weight, size and reliability requirements are major considerations. The main disadvantage of having the flaps pivotally mounted on the capsule itself and form a part of the main body portion thereof is that such a construction results in a waste of vitally needed space, increases the overall weight of the capsule, and interferes with the operation of an adequate parachute assembly for recovering the capsule safely. Where the umbrella opening device is used to open the flaps, the size and weight of the capsule is increased beyond a desirable limit since such a device has to be accommodated inside of the capsule. Some difficulty has also been encountered relative to the storing and opening of the recovery parachute when the umbrella opening device is utilized. The problem presented by opening the flaps with the individual spring opening device is that of reliability. The individual springs have not been reliable to open the flaps uniformly and, accordingly, have caused some of the capsules to initially go into a critical tumble or spin. Several problems and difficulties have also arisen with the use of prior locking mechanisms for locking the flaps in their opened and collapsed positions. In general, these locking mechanisms are bulky, inconvenient to use and unreliable, particularly the ones used to lock the flaps in their opened positions.

In accordance with the present invention, it has been found that the foregoing difficulties and disadvantages presented by the prior stabilization and deceleration mechanisms may be overcome by providing a capsule assembly which comprises (1) a storage means for storing a capsule prior to its recovery, (2) an ejector device for ejecting the capsule from the storage means, (3) a plurality of stabilizing and decelerating flaps adapted to be readily detached from the capsule, and (4) a device for automatically opening and locking the plurality of stabilizing and decelerating flaps. The storage means includes an ejection tube which is fixedly mounted on a vehicle, such, for example, as a rocket. The capsule is stored compactly in the ejection tube until the vehicle reaches a certain altitude. At a predetermined time, the capsule is ejected from the ejection tube by the ejector device. The plurality of stabilizing and decelerating flaps are pivotally mounted on a unitary body which is detachably connected to one end of the capsule. The flaps are also adapted to be collapsible to form a configuration that is similar to the configuration of the capsule. This construction permits the capsule to be stored in the ejection tube in a compact manner and thereby causes the flaps to be held in collapsed positions without the use of a latching mechanism. The device for automatically and uniformly opening the flaps is composed of a plurality of links and a rotatable disc or plate. Each of the links has one end thereof pivotally connected to the plate and the other end pivotally connected to a corresponding flap. The flaps are automatically locked in their opened positions by having the links in direct alignment with the rotary axis of the plate. This arrangement causes each of the links to be in a dead-center position and thereby prevents each flap from collapsing.

Other advantages and objects of this invention will become more apparent from a reading of the following detained description and appended claims taken in conjunction with the accompanying drawing wherein:

FIGURE 1 is an elevational view showing capsule assemblies mounted on a rocket vehicle.

FIGURE 2 is an elevational view of a capsule assembly with portions broken away to show the capsule.

FIGURE 3 is a perspective view showing the capsule with stabilizing and decelerating flaps flared open.

FIGURE 4 is an elevational view showing the recovery of the capsule by a combined balloon and parachute assembly.

FIGURE 5 is a cross sectional view taken along a plane indicated by line 5—5 in FIGURE 6.

FIGURE 6 is a plan view showing the stabilizing and decelerating flaps in their opened positions and the movement of one flap in phantom lines.

FIGURE 7 is a partial plan view showing the stabilizing and decelerating flaps in their collapsed positions.

Referring now in more detail to the drawing wherein like reference numerals designate identical or corresponding parts through the several views, and with special attention to FIGURE 1, reference numeral 10 generally designates a vehicle, shown as a rocket, which the present invention is used in conjunction therewith. The vehicle 10 consists of an upper stage 12 and a lower stage 14, the latter of which has reaction motors 16 connected thereto. A plurality of capsule assemblies 18 are mounted in any conventional manner on a support beam 20 located between the upper and lower stages 12 and 14. It is to be understood, however, that the capsule assemblies 18 may be mounted on any convenient part of the vehicle 10.

As shown more clearly in FIGURE 2, each of the capsule assemblies 18 includes an ejection tube 22 and a capsule 24, the latter of which will be discussed more fully

hereinafter. The ejection tube 22 comprises a hollow, cylindrical body 26 which is fixedly secured to the support beam 20 and is adapted to serve as a storage means for the capsule 24. Mounted on the hollow, cylindrical body 26 is an ejector device 28 which, in this instance, includes a conventional fluid actuator 30 having one end thereof pivotally mounted at 32. The other end of the fluid actuator slidably receives an actuating rod 34. The outer end of the actuating rod 34 is connected to a bracket 36 which carries a finger 38. The ends of the bracket 36 are slidably mounted in grooves 40 formed in a pair of bracket members 42 which are fixedly secured to the hollow, cylindrical body 26. The finger 38 extends through an elongated slot 44 formed in the hollow, cylindrical body 26 between the bracket members 42 and into an opening 46 formed in the capsule 24. In order to withdraw the finger 38 from the opening 46 as the capsule 24 is being ejected from the ejection tube 22, one end of each groove 40 is curved outwardly, as shown in FIGURE 2, to form cam surfaces 48 over which the ends of the bracket 36 are adapted to move. The fluid actuator 30 is actuated by hydraulic fluid or air which is supplied through a line 50 connected to a source (not shown) located inside of the vehicle 10. A cover 52 is fixedly mounted on the hollow, cylindrical body 26 and encompasses the ejector device 28 for protection purposes.

As is clearly shown in FIGURES 3 and 5, the capsule 24 has a stabilization and deceleration unit 54 detachably connected to the upper end thereof. To make the capsule assembly 18 as compact as possible, the stabilization and deceleration unit 54 is constructed of a hollow, unitary body 56 having a plurality of stabilizing and decelerating flaps 58 pivotally connected adjacent to the lower end thereof by hinge elements 60. The flaps 58 are adapted to be opened and collapsed to operative and inoperative positions, respectively. Each of the flaps 58 includes a curved outer surface 62 which increases the aerodynamic characteristics thereof. When the flaps 58 are collapsed in inoperative positions, as shown in FIGURE 7, the curved outer surfaces 62 also form a configuration which is similar to the configuration of the capsule 24. Such a construction permits the stabilization and deceleration unit 54 and capsule 24 to fit snugly within the ejection tube 22 and thereby eliminates the need for a latching mechanism for latching the flaps 58 in their collapsed positions.

The hollow, unitary body 56 includes an upper end wall 64 which is adapted to receive a device for opening and collapsing the flaps 58, such as the rotary device designated generally by reference numeral 68 in FIGURE 5. The rotary device 68 comprises a disc or plate 70 rotatably mounted on a bearing post 72 that is fixedly mounted on the upper end wall 64. To prevent excessive play in the plate 70, a washer element 74 and cotter pin 76 is positioned on the bearing post 72 above the plate 70. The plate 70 is rotated by a spiral spring 78 positioned around the bearing post 72 with one end thereof anchored to the plate 70 by an anchor bolt 80 and the other end fixedly positioned in a slot 82 in the bearing post 72. The spiral spring 78 is held in place around the bearing post 72 by a washer 84 and cotter pin 86. Actuation of the flaps 58 is accomplished by the movement of a plurality of links 88, each of which has one end connected to the plate 70 by a pivotable connection 90 and the other end thereof pivotally connected to the upper end of the corresponding flaps by a universal joint 92. In FIGURE 5, the universal joint 92 is shown consisting of a bifurcated element 94, a horizontal coupling pin 96 and a vertical coupling pin 98. The horizontal coupling pin 96 pivotally connects one end of the bifurcated element 94 to a bifurcation 100 located on the upper end of the flap 58; whereas, the vertical coupling pin 98 pivotally connects the other end thereof to the outer end of the link 88.

FIGURES 5 and 6 show a latching mechanism 102 for latching the plate 70 in a position to thereby prevent collapsing of the flaps 58 when they are in their opened or fully pivoted positions. The latching mechanism 102 includes a latch arm 104 pivotally mounted at 106 to the plate 70, a stop pin 108 fixedly mounted on the plate 70, and a slot 110 in the latch arm 104 for slidably receiving the stop pin 108. The latch arm 104 has a cam surface 112 intermediate the ends thereof and a slot 114 adjacent the free end. A latch pin 116 is fixedly mounted on the upper end wall 64 in such a position as to engage the cam surface 112 and be received in the slot 114 when the plate 70 is rotated. One end of a leaf spring 118 is connected to the plate 70 by a bracket 120 and the other end thereof slidably engages the latch arm 104 so as to urge the latter in a clockwise direction. When the plate 70 is rotated by the spiral spring 78, the latch arm 104 moves therewith and is rotated in a counter-clockwise direction by engagement of the cam surface 112 with the latch pin 116. After the plate 70 has rotated through approximately 90°, the latch pin 116 is in alignment with the slot 114 and the leaf spring 118 rotates the latch arm 104 clockwise to engage the latch pin 116 in the slot 114. While only one latching mechanism 102 is illustrated, it is apparent that two or more may be employed if deemed necessary. The latching mechanism 102 may also be reversed by mounting the latch arm 104 on the upper end wall 64 and latch pin 116 on the plate 70.

It should be noted that when collapsed, as shown in FIGURE 7, the flaps 58 extend above the plate 70, thereby causing the outer end of each of the links 88 to be raised sufficiently to permit each link to overlap an adjacent link. The links 88 are connected to the plate 70 in such a manner as to allow the plate 70 to rotate through 90° between the fully collapsed and fully opened positions of the flaps 58. The movement of one link 88 and one flap 58' is shown in phantom lines in FIGURE 6. When the plate 70 is latched in place by the latching mechanism 102, the longitudinal axis of each of the links 88 is in direct alignment with the rotary axis of the plate 70. Such an arrangement causes each of the links 88 to be in a dead-center position with respect to the center of the bearing post 72 and thereby serve as an additional locking device to further prevent the flaps 58 from collapsing when outer forces are applied thereagainst.

As mentioned hereinbefore, the stabilization and deceleration unit 54 is detachably connected to the upper end of the capsule 24. As shown in FIGURE 5, this is accomplished by means of shear screws 122 which extend through the lower end of the hollow, unitary body 56 and a depressed ring 124 formed integrally with the upper end of the capsule 24. The hollow, unitary body 56 houses a combined balloon and parachute assembly 126 which is inflated by an inflation device (not shown) located inside of the capsule 24. Inflation of the combined balloon and parachute assembly 126 takes place at a predetermined altitude causing the shear screws 122 to be sheared and the stabilization and deceleration unit 54 to thereby be detached from the capsule 24. By so removing the stabilization and deceleration unit 54, the capsule 24 becomes substantially lighter and is more easily recovered by the combined balloon and parachute assembly 126. After the stabilization and deceleration unit 54 is completely separated from the capsule 24, the balloon and parachute assembly 126 becomes operative as shown in FIGURE 4. If the capsule 24 lands in water, the balloon will prevent it from sinking and will also serve as a marker so that it may be readily found.

The operation of the recovery means of the instant invention will now be summarized. The vehicle 10 which carries the capsule assembly 18, as illustrated in FIGURE 1, is launched in any suitable manner and is propelled away from the earth by the reaction motors 16. At a predetermined time and altitude, liquid or gas is supplied to the actuator 30, thereby causing the finger 38 to eject the stored capsule 24 from the ejection tube 22. Immediately after the capsule 24 leaves the ejection

tube 22, the spiral spring 78 automatically rotates the disc 70 and the links 88 move the stabilizing and decelerating flaps 58 uniformly to their opened positions. The elongated flaps 58 are locked in their opened positions in the manner described hereinbefore. As the capsule 24 falls freely through the upper atmosphere, as shown in FIGURE 3, the flaps 58 stabilize the capsule against tumble and spin and increase the drag force thereon. When the capsule 24 reaches a predetermined altitude, the combined balloon and parachute assembly 126 inflates and thereby disconnects the stabilization and deceleration unit 54 from the capsule by shearing the shear screws 122. The stabilization and deceleration unit 54 then completely separates from the capsule 24 and the combined balloon and parachute assembly 126 becomes operative, as shown in FIGURE 4, to deliver the capsule 24 safely to the earth. Where the ocean is chosen as the recovery site and the capsule 24 lands therein, the combined balloon and parachute assembly 126 will also serve as a means for floating and marking the capsule so that it may be retrieved readily by a ship or helicopter.

Obviously numerous modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A device for stabilizing and decelerating a capsule comprising:

(A) a unitary body adapted to be detachably connected to one end of said capsule;

(B) a plurality of flaps pivotally mounted on said unitary body adjacent one end thereof for movement between collapsed positions and opened positions;

(C) a spring urged plate rotatably mounted about a rotary axis on the other end of said unitary body;

(D) a plurality of pivotable links interposed between said spring urged plate and said plurality of flaps; and

(E) a latching mechanism positioned between said spring urged plate and said unitary body and adapted to latch said plurality of flaps in said opened positions.

2. A device for stabilizing and decelerating a capsule as defined in claim 1 wherein:

(A) the outer surfaces of said plurality of flaps form a configuration that is similar to the configuration of said capsule when said plurality of flaps are in said collapsed positions.

3. A device for stabilizing and decelerating a capsule as defined in claim 1 wherein:

(A) the longitudinal axis of each of said plurality of pivotable links is in direct alignment with said rotary axis when said plurality of flaps are latched in said opened positions.

4. A device for stabilizing and decelerating a capsule comprising:

(A) a plurality of flaps pivotally mounted on said capsule for movement between collapsed positions and opened positions;

(B) a spring urged plate rotatably mounted about a rotary axis on said capsule;

(C) a plurality of pivotable links interposed between said spring urged plate and said plurality of flaps; and

(D) a latching mechanism positioned between said spring urged plate and said capsule and adapted to latch said plurality of flaps in said opened positions.

5. A device for stabilizing and decelerating a capsule as defined in claim 4 wherein:

(A) the outer surfaces of said plurality of flaps form a configuration that is similar to the configuration of said capsule when said plurality of flaps are in said collapsed positions.

6. A device for stabilizing and decelerating a capsule as defined in claim 5 wherein:

(A) the longitudinal axis of each of said plurality of pivotable links is in direct alignment with said rotary axis when said plurality of flaps are latched in said opened positions.

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